

■ Mechanical installation



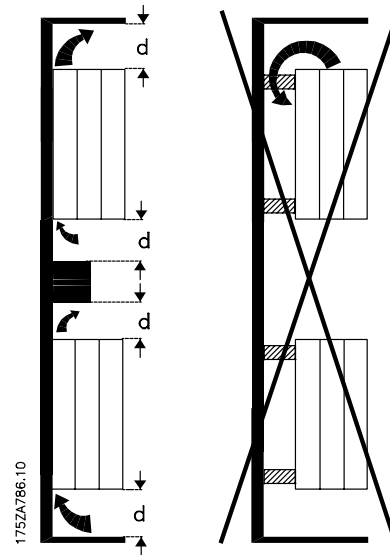
Please pay attention to the requirements that apply to integration and field mounting kit, see the below list. The information given in the list must be observed to avoid serious damage or injury, especially when installing large units.

The adjustable frequency drive *must* be installed vertically.

The adjustable frequency drive is cooled by means of air circulation. For the unit to be able to release its cooling air, the *minimum* distance over and below the unit must be as shown in the illustration below. To protect the unit from overheating, it must be ensured that the ambient temperature *does not rise above the max. temperature stated for the adjustable frequency drive and that the 24-hour average temperature is not exceeded*. The max. temperature and 24-hour average can be seen from the General Technical section.

When installing the adjustable frequency drive on a non flat surface, i.e. a frame, please consult the instruction, MN.50.XX.YY.

If the ambient temperature is in the range of 45° C - 55° C, derating of the adjustable frequency drive will be required in accordance with the diagram in the Design Guide. The service life of the adjustable frequency drive will be reduced if no allowance is made for the derating for ambient temperature.



All units require a minimum space above and below the enclosure.

Installation

■ Installation of VLT 8006-8352

All AFDs must be installed in a way that ensures proper cooling.

Cooling



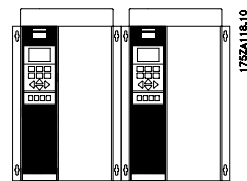
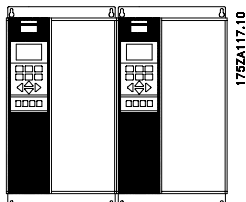
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Side by side/flange by flange

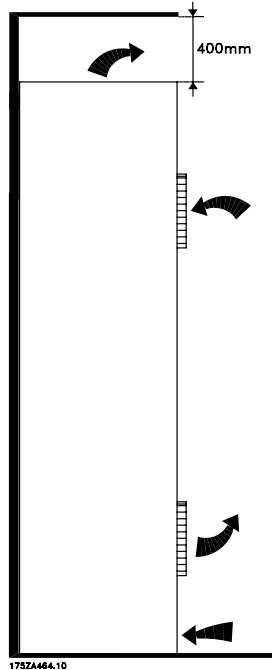
All AFDs can be mounted side by side/flange by flange.



	d [mm/in]	Comments
Compact (all enclosure types)		
VLT 8006-8011, 380-480 V	100/3.9	Installation on a plane, vertical surface (no spacers)
VLT 8002-8011, 525-600 V	100/3.9	
VLT 8006-8032, 200-240 V	200/7.9	Installation on a plane, vertical surface (no spacers)
VLT 8016-8072 380-480 V	200/7.9	
VLT 8102-8122 380-480 V	225/8.9	
VLT 8016-8072 525-600 V	200/7.9	
VLT 8042-8062, 200-240 V	225/8.9	Installation on a plane, vertical surface (no spacers)
VLT 8100-8300, 525-600 V	225/8.9	
		IP 54 filter mats must be changed when they are dirty.
VLT 8152-8352, 380-480 V	225/8.9	Installation on a plane, vertical surface (spacers can be used). IP 54 filter mats must be changed when they are dirty.

■ Installation of VLT 8450-8600 380-480 V Compact IP 00/Chassis, IP 20/NEMA 1 and IP 54/NEMA 12

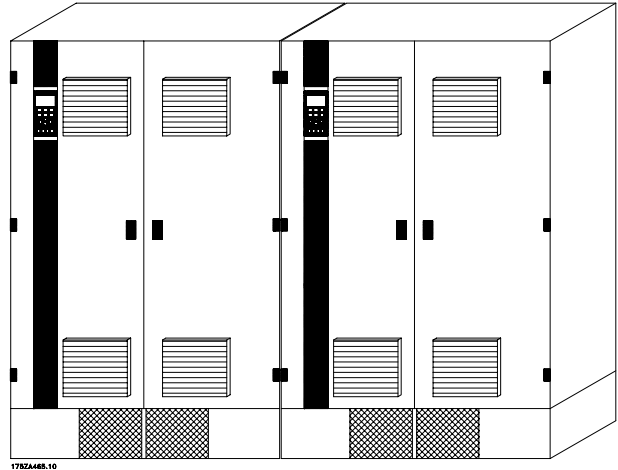
Cooling



All units in the above-mentioned series require a minimum space of 400 mm (15.8 in) above the enclosure and must be installed on a plane floor. This applies to both IP 00/Chassis, IP 20/NEMA 1 and IP 54/NEMA 12 units.

Gaining access to VLT 8450-8600 requires a minimum space of 605 mm (23.8 in) in front of the AFD.

Side-by-side



All IP 00/Chassis, IP 20/NEMA 1 and IP 54/NEMA 12 units in the above-mentioned series can be installed side by side without any space between them, since these units do not require cooling on the sides.

Installation

■ IP 00 VLT 8450-8600 380-480 V

The IP 00/Chassis unit is designed for installation in a cabinet when installed according to the instructions

in the Installation Guide MG.56.AX.YY. Please note, that the same conditions as for NEMA 1/ IP20 and IP54/NEMA 12 must be fulfilled.

■ General information about electrical installation

■ High voltage warning



The voltage of the AFD is dangerous whenever the equipment is connected to line. Incorrect installation of the motor or the AFD may cause damage to the equipment, serious personal injury or death. Consequently, the instructions in this manual, as well as national and local safety regulations, must be complied with. Touching the electrical parts may be fatal - even after disconnection from line:

Using VLT 8006-8062, 200-240 V wait at least 15 minutes

Using VLT 8006-8072, 380-480 V wait at least 15 minutes

Using VLT 8102-8352, 380-480 V wait at least 20 minutes

Using VLT 8450-8600, 380-480 V wait at least 15 minutes

Using VLT 8002-8006, 525-600 V wait at least 4 minutes

Using VLT 8008-8027, 525-600 V wait at least 15 minutes

Using VLT 8032-8300, 525-600 V wait at least 30 minutes



NOTE

It is the user's or certified electrician's responsibility to ensure correct grounding and protection in accordance with applicable national and local codes and standards.

■ Grounding

The following basic issues need to be considered when installing an AFD.

- **Safety grounding:** Please note that the AFD has a high leakage current and must be grounded appropriately for safety reasons. Apply local safety regulations.
- **High-frequency grounding:** Keep the ground wire connections as short as possible.

Connect the different ground systems at the lowest possible conductor impedance. The lowest possible conductor impedance is obtained by keeping the conductor as short as possible and by using the greatest possible surface area. A flat conductor, for example, has a lower HF impedance than a round conductor for the same conductor cross-section C_{Vess} .

If more than one device is installed in cabinets, the cabinet rear plate, which must be made of metal, should be used as a common ground reference plate. The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. This avoids having different HF voltages for the individual devices and avoids the risk of radio interference currents running in connection cables that may be used between the devices. The radio interference will have been reduced.

In order to obtain a low HF impedance, use the fastening bolts of the devices as HF connection to the rear plate. It is necessary to remove insulating paint or similar from the fastening points.

■ Cables

Control cables and the filtered line cable should be installed separate from the motor cables so as to avoid interference overcoupling. Normally, a distance of 204mm (8 in) will be sufficient, but it is recommended to keep the greatest possible distance wherever possible, especially where cables are installed in parallel over a substantial distance.

With respect to sensitive signal cables, such as telephone cables and data cables, the greatest possible distance is recommended with a minimum of 1m (3 ft) per 5m (15 ft) of power cable (line and motor cable). It must be pointed out that the necessary distance depends on the sensitivity of the installation and the signal cables, and that therefore no precise values can be stated.

If cable jaws are used, sensitive signal cables are not to be placed in the same cable jaws as the motor cable or brake cable.

If signal cables are to cross power cables, this should be done at an angle of 90 degrees.

Remember that all interference-filled in- or outgoing cables to/from a cabinet should be shielded/armored or filtered.

■ Shielded/armored cables

The shield must be a low HF-impedance shield. This is ensured by using a braided shield of copper, aluminium

or iron. Shield armor intended for mechanical protection, for example, is not suitable.

■ Extra protection with regard to indirect contact

ELCB relays, multiple protective grounding or grounding can be used as extra protection, provided that local safety regulations are complied with. In the case of an ground fault, a DC content may develop in the faulty current.

Never use ELCB relays, type A, since such relays are not suitable for DC fault currents.

If ELCB relays are used, this must be:

- Suitable for protecting equipment with a direct current content (DC) in the faulty current (3-phase bridge rectifier)
 - Suitable for power-up with short charging current to ground
 - Suitable for a high leakage current
-

■ RFI switch

Mains supply isolated from earth:

If the adjustable frequency drive is supplied from an isolated mains source (IT mains and grounded delta), the RFI switch can be turned off (OFF). In OFF position, the internal RFI capacities (filter capacitors) between the chassis and the intermediate circuit are cut off to avoid damage to the intermediate circuit and to reduce the earth capacity currents (according to IEC 61800-3).



NOTE

The RFI switch is not to be operated with mains connected to the unit. Check that the mains supply has been disconnected before operating the RFI switch.



NOTE

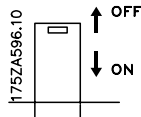
Open RFI switch is only allowed at factory set switching frequencies.



NOTE

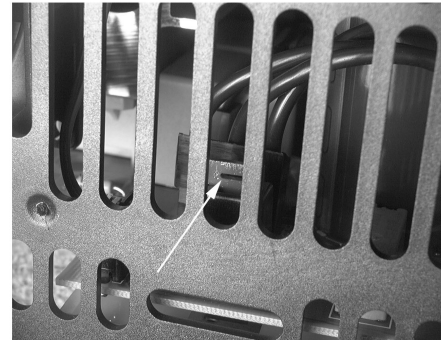
The RFI switch disconnects the capacitors galvanically to ground.

The red switches are operated by means of e.g. a screwdriver. They are set in the OFF position when they are pulled out and in ON position when they are pushed in (see drawing below). Factory setting is ON.



Mains supply connected to earth:

The RFI switch must be in ON position in order for the adjustable frequency drive to comply with the EMC-standard.



Compact IP 20/NEMA 1

VLT 8006 - 8011 380 - 480 V

VLT 8002 - 8011 525 - 600 V



Compact IP 20/NEMA 1

VLT 8016 - 8027 380 - 480 V

VLT 8006 - 8011 200 - 240 V

VLT 8016 - 8027 525 - 600 V

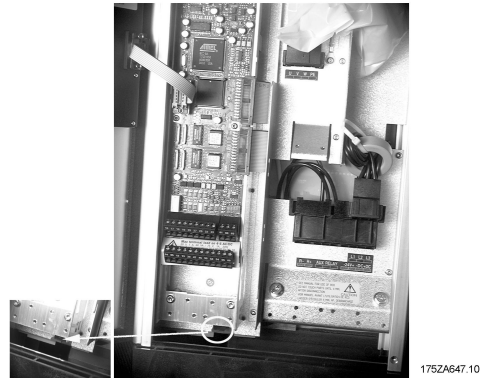


Compact IP 20/NEMA 1

VLT 8032 - 8042 380 - 480 V

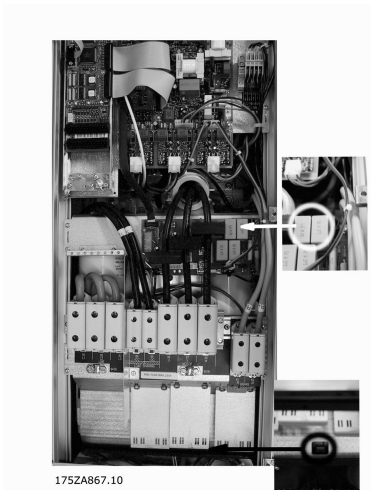
VLT 8016 - 8022 200 - 240 V

VLT 8032 - 8042 525 - 600 V



Compact IP 54/NEMA 12
VLT 8006 - 8011 380 - 480 V

Compact IP 20/NEMA 1
VLT 8052 - 8122 380 - 480 V
VLT 8027 - 8032 200 - 240 V
VLT 8052 - 8072 525 - 600 V



Compact IP 54/NEMA 12
VLT 8016 - 8032 380 - 480 V
VLT 8006 - 8011 200 - 240 V

Compact IP 54/NEMA 12
VLT 8102 - 8122 380 - 480 V



Compact IP 54/NEMA 12
VLT 8042 - 8072 380 - 480 V
VLT 8016 - 8032 200 - 240 V

■ High voltage test

A high voltage test can be carried out by short-circuiting terminals U, V, W, L₁, L₂ and L₃ and energizing by max. 2.5 kV DC for one second between this short-circuit and the chassis.



NOTE

The RFI switch must be closed (position ON) when high voltage tests are carried out. The line and motor connection must be interrupted in the case of high voltage tests of the total installation if the leakage currents are too high.

■ Heat emission from VLT 8000 AQUA

The tables in *General technical data* show the power loss P_φ (W) from VLT 8000 AQUA. The maximum cooling air temperature t_{IN, MAX} is 40° C (104° F) at 100% load (of rated value).

■ Ventilation of integrated VLT 8000 AQUA

The quantity of air required for cooling AFD can be calculated as follows:

1. Add up the values of P for all the AFDs to be integrated in the same panel.
The highest cooling air temperature (t_{IN}) present must be lower than t_{IN, MAX} 40° C (104° F).
The day/night average must be 5°C (9° F) lower.
The outlet temperature of the cooling air must not exceed: t_{OUT, MAX} 45° C (113° F).
2. Calculate the permissible difference between the temperature of the cooling air (t_{IN}) and its outlet temperature (t_{OUT}):
 $\Delta t = 45^\circ \text{ C (113}^\circ \text{ F) - } t_{\text{IN}}$.
3. Calculate the required

$$\text{quantity of air} = \frac{\sum P_{\phi} \times 3.1}{\Delta t} \text{ m}^3/\text{h}$$

Insert Δt in Kelvin

The outlet from the ventilation must be placed above the highest-mounted AFD.
Allowance must be made for the pressure loss across the filters and for the fact that the pressure is going to drop as the filters are choked.

■ EMC-correct electrical installation

525-600 V units do not comply with European EMC and Low Voltage Directives.

The following is a guideline to good engineering practice, when installing drives. Following these guidelines is advised, where compliance with EN 50081, EN 55011 or EN 61800-3 *First environment* is required. If the installation is in EN 61800-3 *Second environment*, then it is acceptable to deviate from these guidelines. It is however not recommended. See also *CE labelling*, *Emission* and *EMC test results* in this manual.

Good engineering practice to ensure EMC-correct electrical installation:

- Use only braided shielded/armored motor cables and braided shielded/armored control cables. The shield should provide a minimum coverage of 80%. The shield material must be metal, not limited to but typically copper, aluminum, steel or lead. There are no special requirements for the line cable.
- Installations using rigid metal conduits are not required to use shielded cable, but the motor cable must be installed in conduit separate from the control and line cables. Full connection of the conduit from the drive to the motor is required. The EMC performance of flexible conduits varies a lot and information from the manufacturer must be obtained.
- Connect the shield/armor/conduit to ground at both ends for motor cables as well as for control cables. See also *Grounding of braided shielded/armored control cables*.
- Avoid terminating the shield/armor with twisted ends (pigtailed). Such a termination increases the high frequency impedance of the shield, which reduces its effectiveness at high frequencies. Use low impedance cable clamps or EMC cable glands instead.
- It is important to have good electrical contact between the mounting plate on which the AFD is installed and the metal chassis of the AFD unit.
Exception:
 - IP54/NEMA 12 units designed for wall mounting
 - VLT 8152-8600 (380-480 V) IP20/NEMA 1
 - VLT 8042-8062 (200-240 V) IP20/NEMA 1

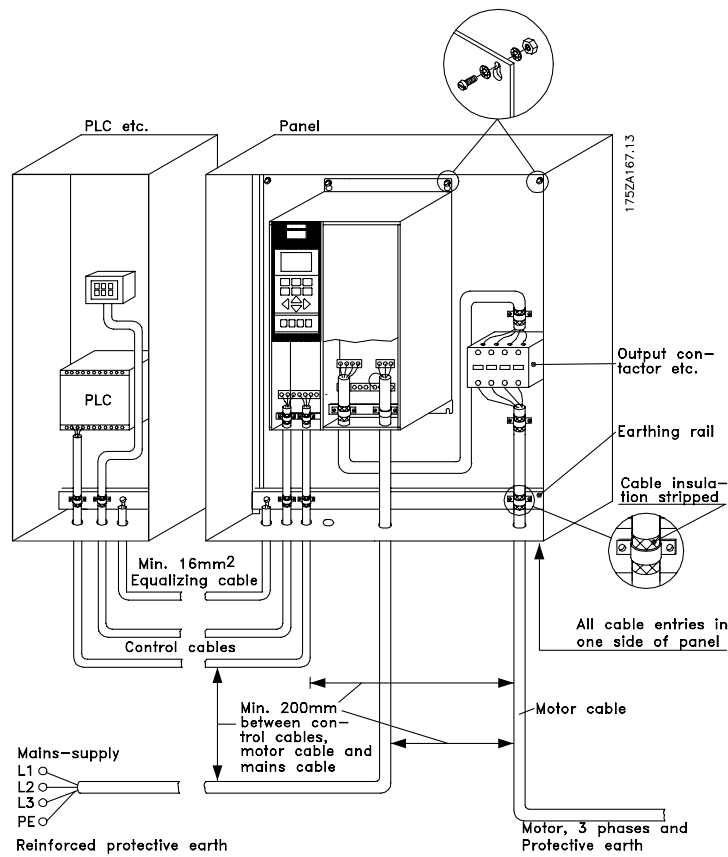
This however does not apply to IP54/NEMA 12 units as they are designed for wall mounting and VLT 8152-8600, 380-480 VAC and VLT 8042-8062, 200-240 VAC in IP20/NEMA 1 enclosure.

- Use starwashers and galvanically conductive installation plates to secure good electrical connections for IP00/Chassis and IP20/NEMA 1 installations.
- Avoid using unshielded/unarmored motor or control cables inside cabinets housing the drive(s), whenever this can be avoided.
- An uninterrupted high frequency connection between the AFD and the motor is required for IP54/NEMA 12 units.

The next illustration shows an example of an EMC-correct electrical installation of an IP 20/NEMA 1 AFD; the AFD has been installed in a cabinet (enclosure) together with an output contactor and is connected to a PLC which, in this example, is installed in a separate cabinet. For IP 54/NEMA 12 units, VLT 8152-8600 (380-480 V) and VLT 8042-8062 (200-240 V) units in IP20/NEMA 1 enclosures; shielded cables are connected by using EMC conduits to assure proper EMC performance. (See next illustration.)

Other ways of making the installation may give as good an EMC performance, provided the above engineering practice guidelines are followed.

Please note, that when the installation is not made according to these guidelines as well as when unshielded cables and control wires are used, some emission requirements are not complied with, although the immunity requirements are fulfilled.



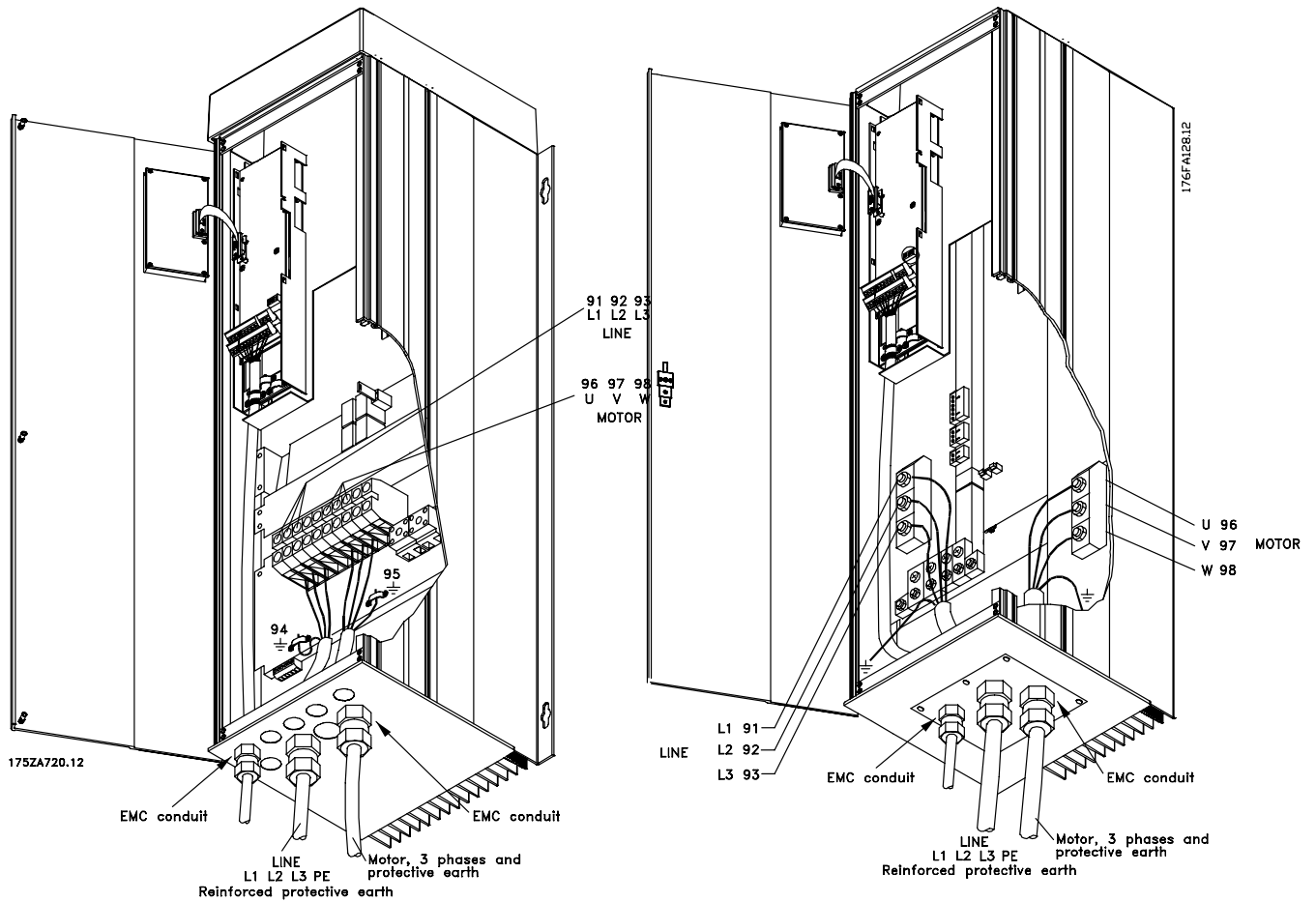
Installation



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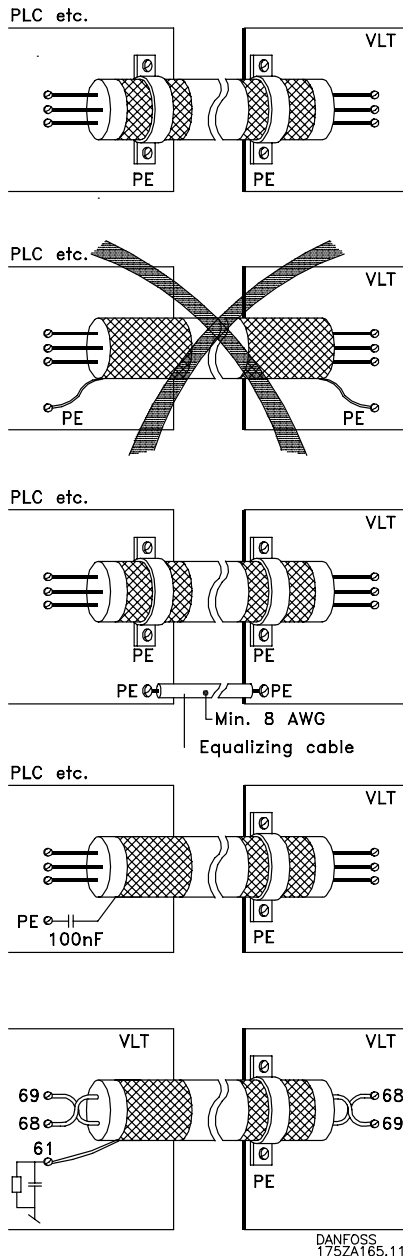




■ Earthing/Grounding of shielded/armored control cables

Generally speaking, control cables must be shielded/armored and the shield must be connected by means of a cable clamp at both ends to the metal cabinet of the unit.

The drawing below indicates how correct earthing/grounding is carried out.



Correct earthing/grounding

Control cables and cables for serial communication must be fitted with cable clamps at both ends to ensure the best possible electrical contact.

Wrong earthing/grounding

Do not use twisted cable ends (pigtails), since these increase the shield impedance at high frequencies.

Protection with respect to ground potential between PLC and AFD

If the ground potential between the AFD and the PLC (etc.) is different, electric noise may occur that will disturb the whole system. This problem can be solved by fitting an equalizing cable, to be placed next to the control cable. Minimum cable cross-section: 8 AWG.

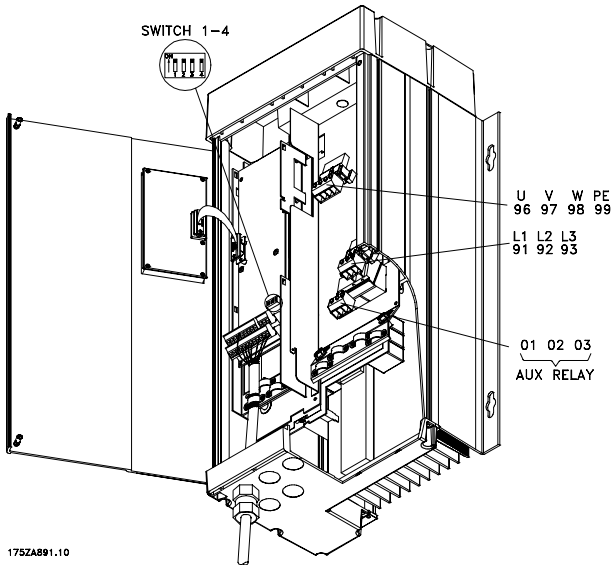
For 50/60 Hz ground loops

If very long control cables are used, 50/60 Hz ground loops may occur that will disturb the whole system. This problem can be solved by connecting one end of the shield to via a ground 100nF capacitor (keeping leads short).

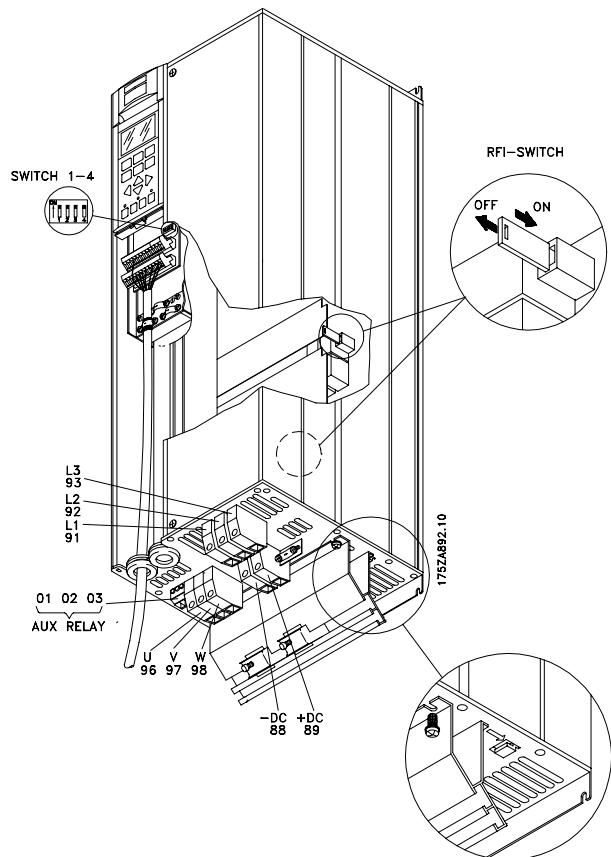
Cables for serial communication

Low-frequency noise currents between two AFD can be eliminated by connecting one end of the shield to terminal 61. This terminal is connected to ground via an internal RC link. It is recommended to use twisted-pair cables to reduce the differential mode interference between the conductors.

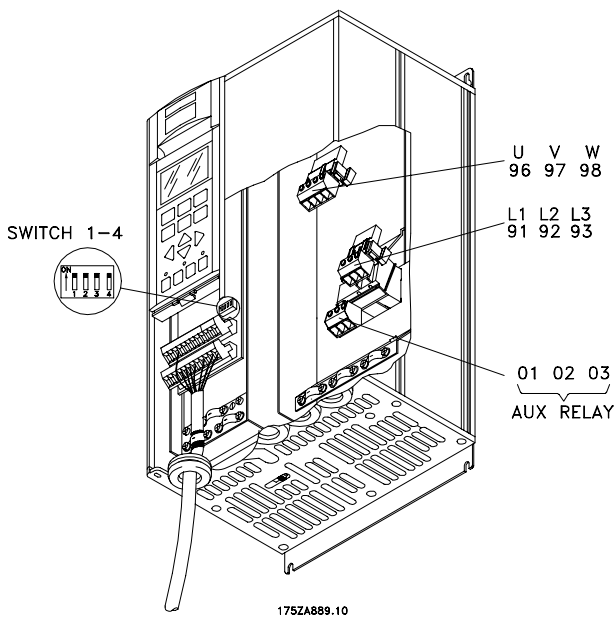
■ Electrical installation, enclosures



Compact IP 54/NEMA 12
VLT 8006-8011, 380-480 V

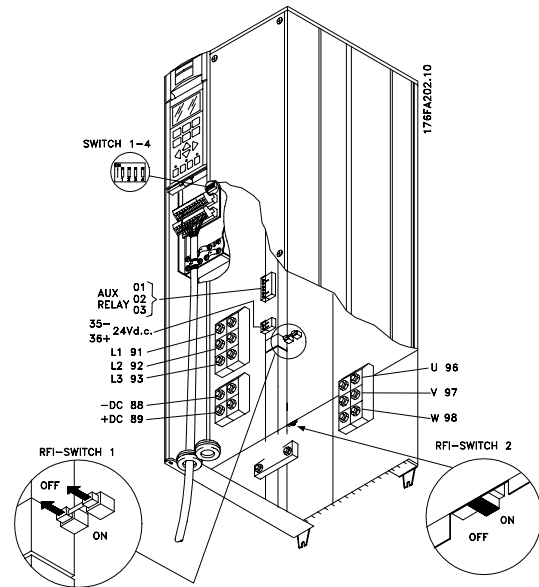
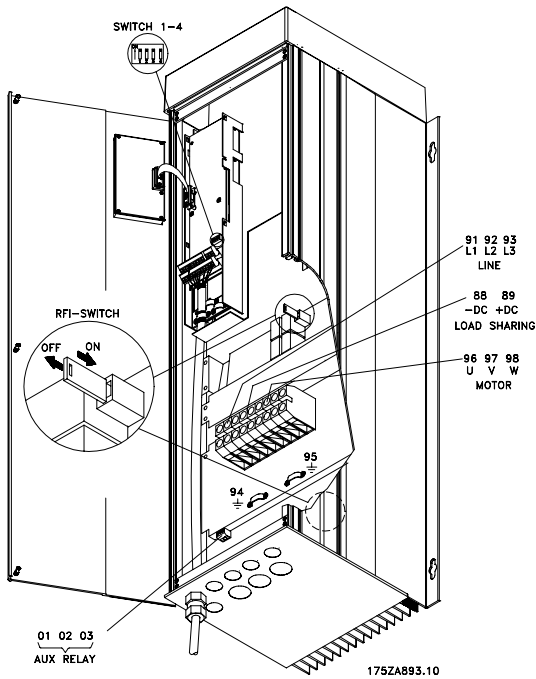


Compact IP 20/NEMA 1
VLT 8006-8032, 200-240 V
VLT 8016-8072, 380-480 V
VLT 8016-8072, 525-600 V



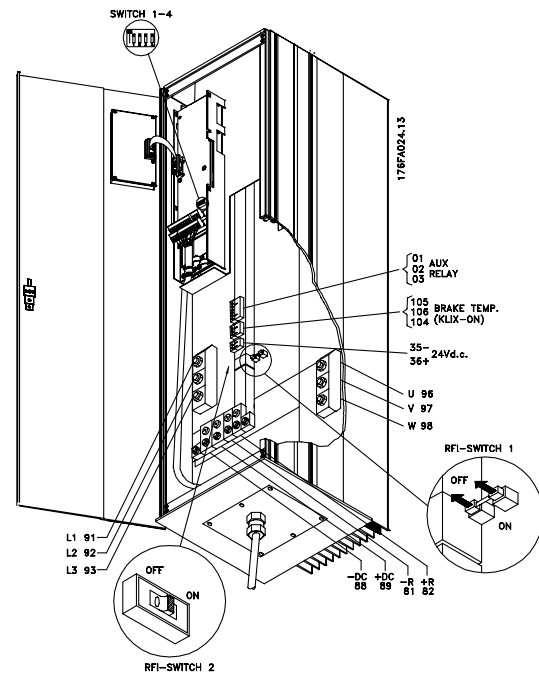
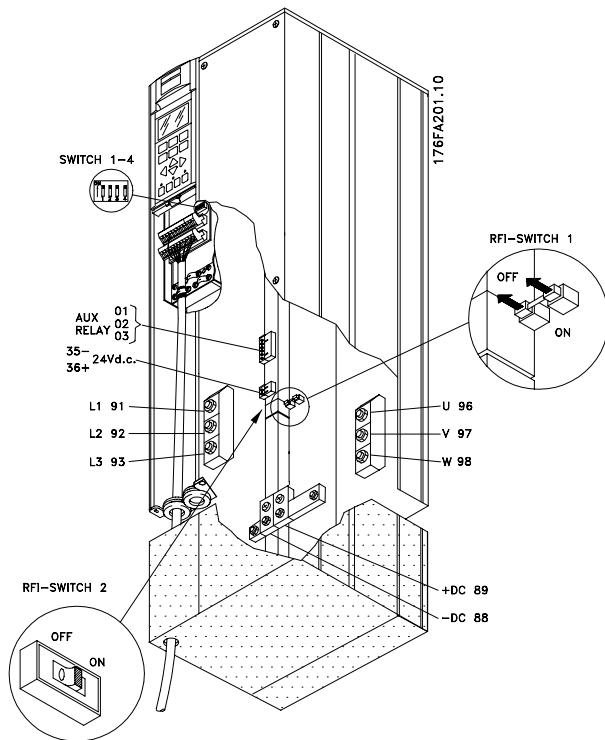
Compact IP 20/NEMA 1
VLT 8006-8011, 380-480 V
VLT 8002-8011, 525-600 V

VLT 8100-8150, 525-600 V



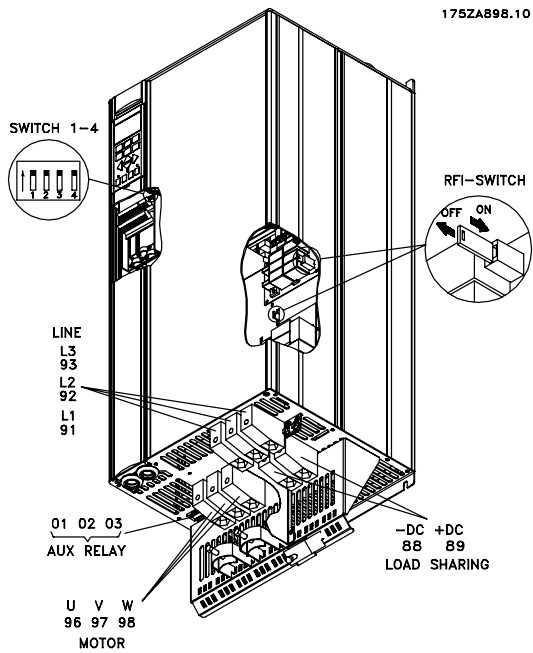
Compact IP 00/Chassis
VLT 8042-8062, 200-240 V
VLT 8100-8150, 525-600 V

Compact IP 54/NEMA 12
VLT 8006-8032, 200-240 V
VLT 8016-8072, 380-480 V

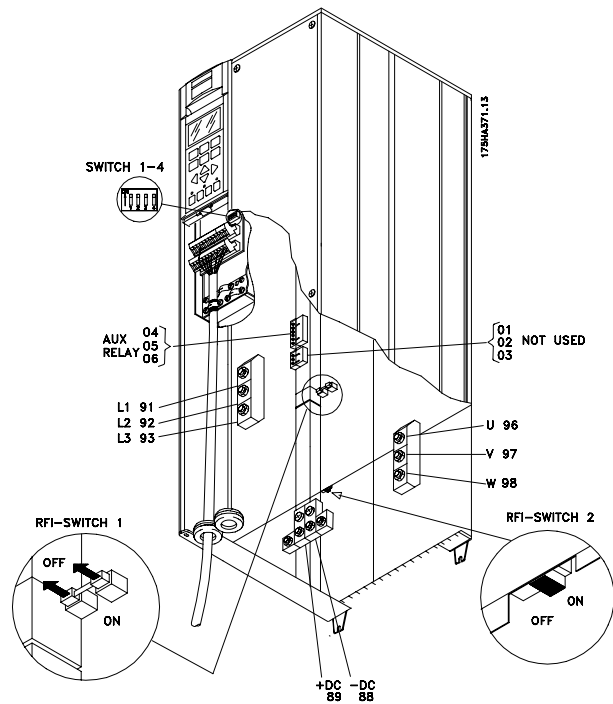


Compact IP 54/NEMA 12
VLT 8042-8062, 200-240 V

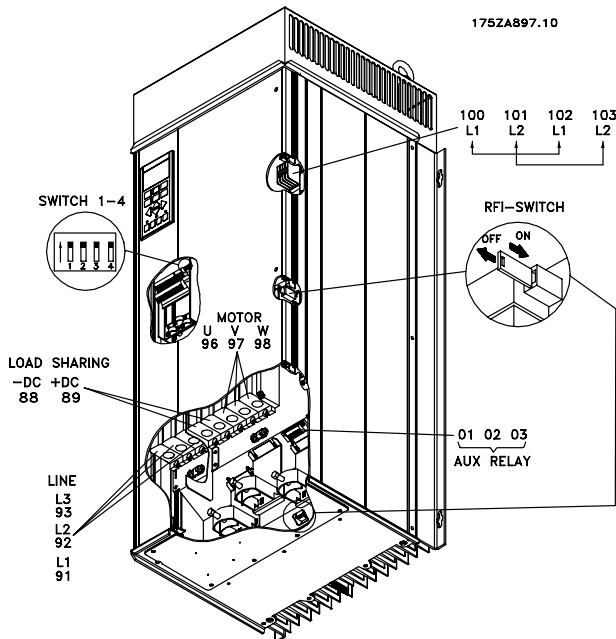
Compact IP 20/NEMA 1
VLT 8042-8062, 200-240 V



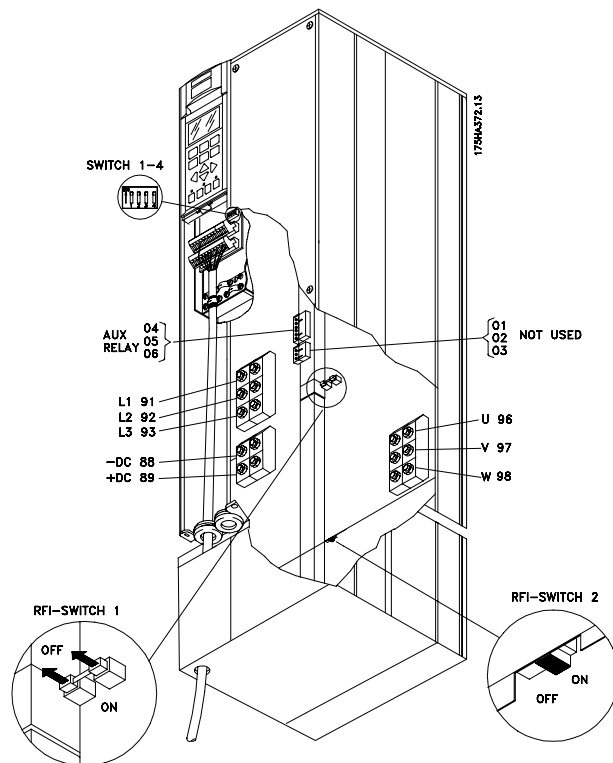
Compact IP 20/NEMA 1
VLT 8102-8122, 380-480 V



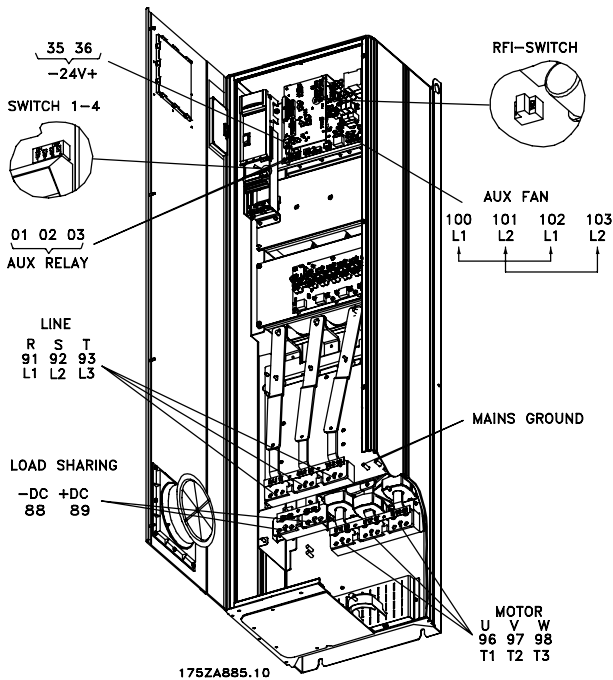
IP 00/Chassis
VLT 8200-8300, 525-600 V



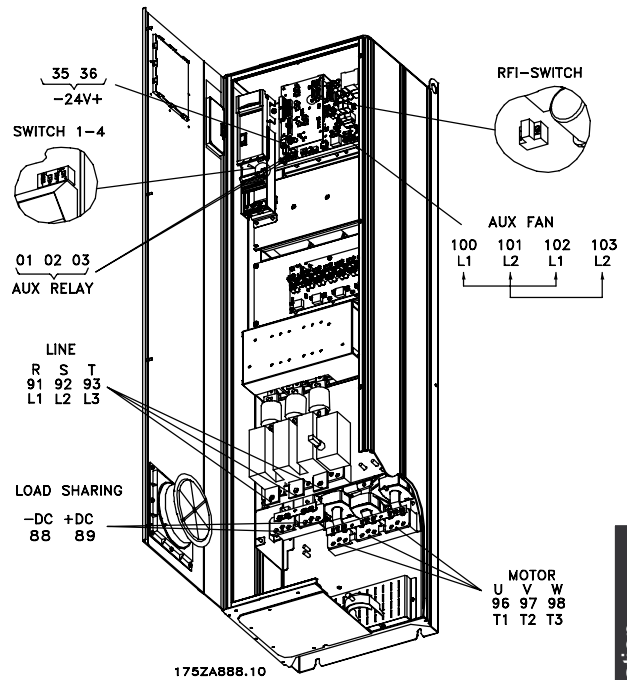
Compact IP 54/NEMA 12
VLT 8102-8122, 380-480 V



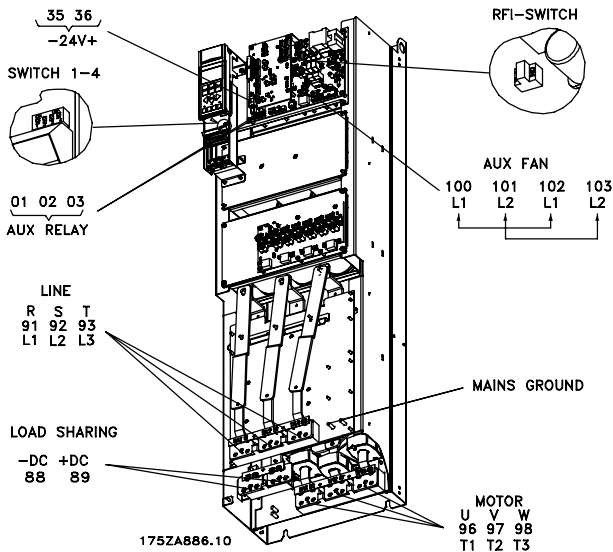
Compact IP 20/NEMA 1
VLT 8200-8300, 525-600 V



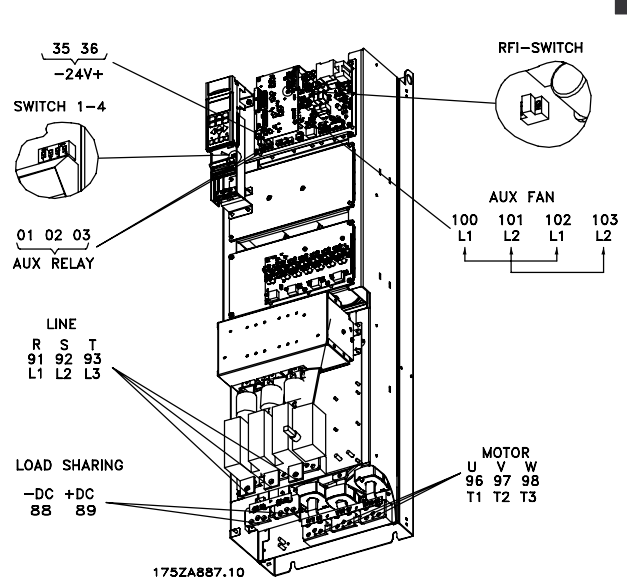
IP 54/NEMA 12, IP 21/NEMA 1
VLT 8152-8352, 380-480 V



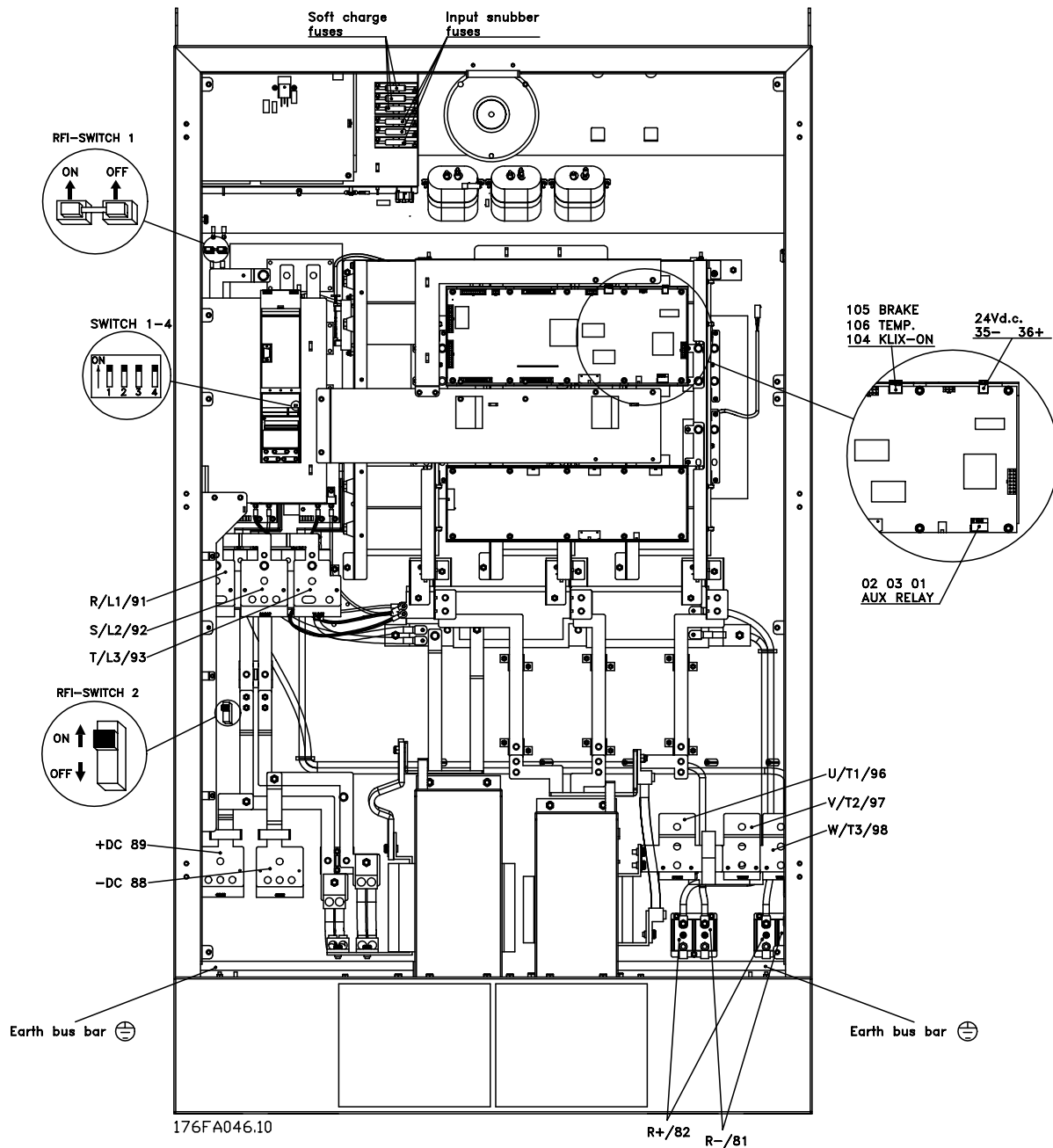
IP 54/NEMA 12, IP 21/NEMA 1 with disconnect and main fuse
VLT 8152-8352, 380-480 V



IP 00/Chassis
VLT 8152-8352, 380-480 V

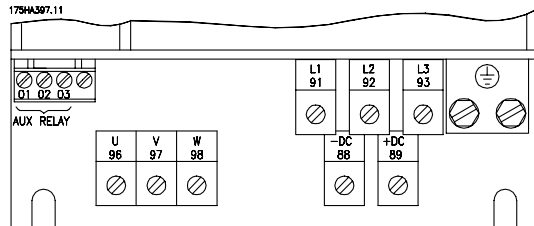


IP 00/Chassis with disconnect and main fuse
VLT 8152-8352, 380-480 V



Compact IP 00/Chassis, IP 20/NEMA 1,
and IP 54/NEMA 12
VLT 8450-8600, 380-480 V

■ Electrical installation, power cables

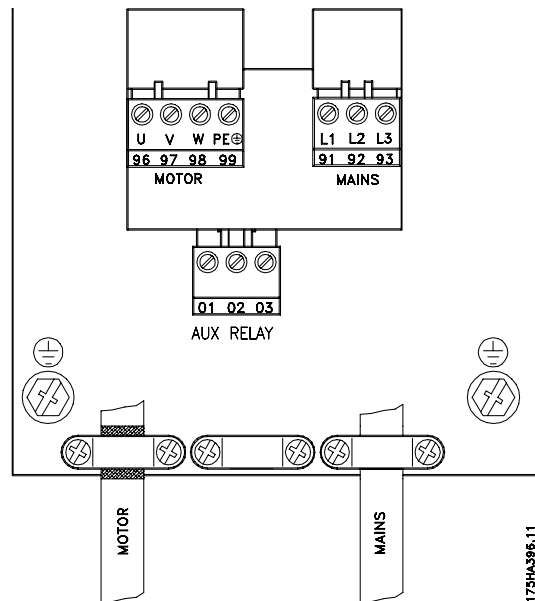


IP 20/NEMA 1

VLT 8006-8032, 200-240 V

VLT 8016-8122, 380-480 V

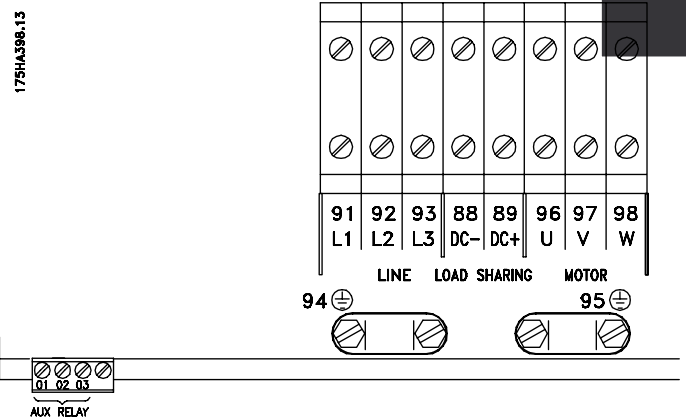
VLT 8016-8072, 525-600 V



Compact IP 20/NEMA 1, and IP 54/NEMA 12

VLT 8006-8011, 380-480 V

VLT 8002-8011, 525-600 V



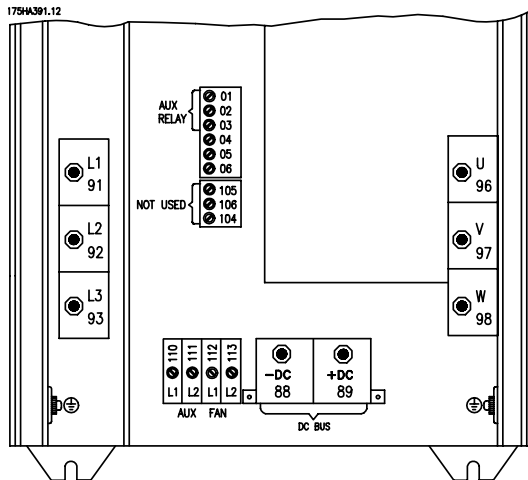
IP 54/NEMA 12

VLT 8006-8032, 200-240 V

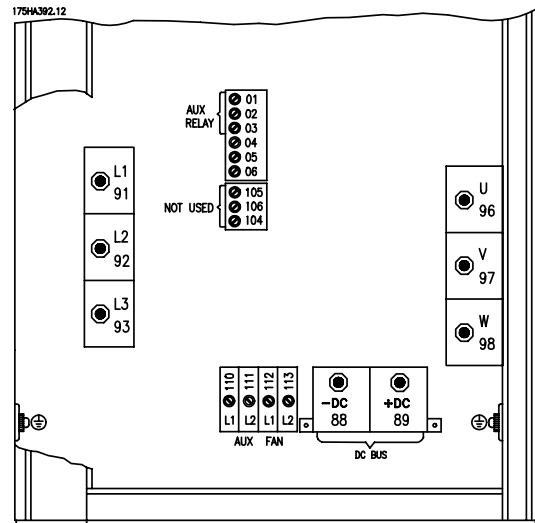
VLT 8016-8072, 380-480 V

Installation

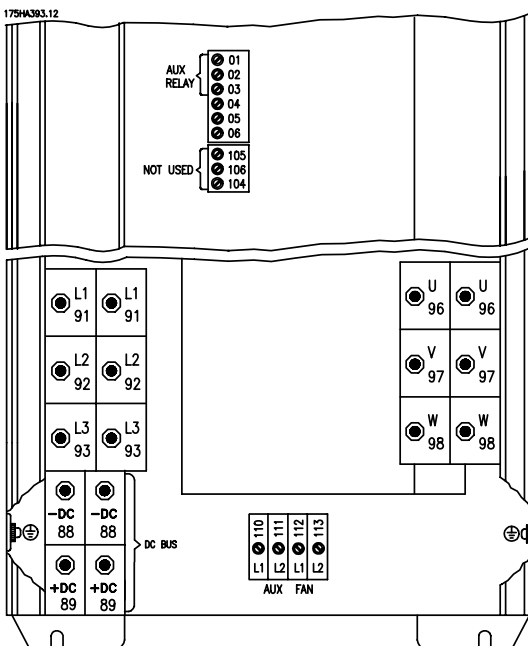
■ Electrical installation, power cables



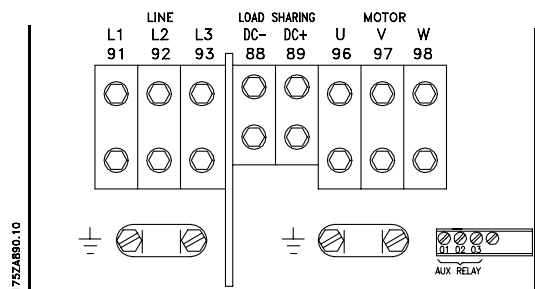
IP 00/Chassis and IP 20/NEMA 1
VLT 8042-8062, 200-240 V
VLT 8100-8150, 525-600 V



IP 54/NEMA 12
VLT 8042-8062, 200-240 V



IP 00/Chassis and IP 20/NEMA 1
VLT 8200-8300, 525-600 V



Compact IP 54 /NEMA 12
VLT 8102-8122, 380-480 V

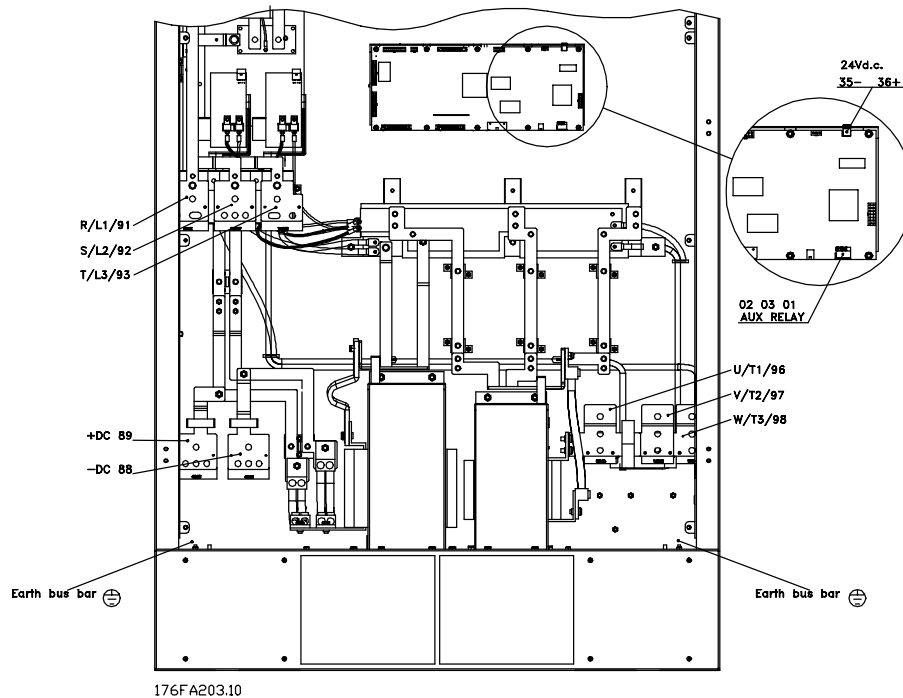


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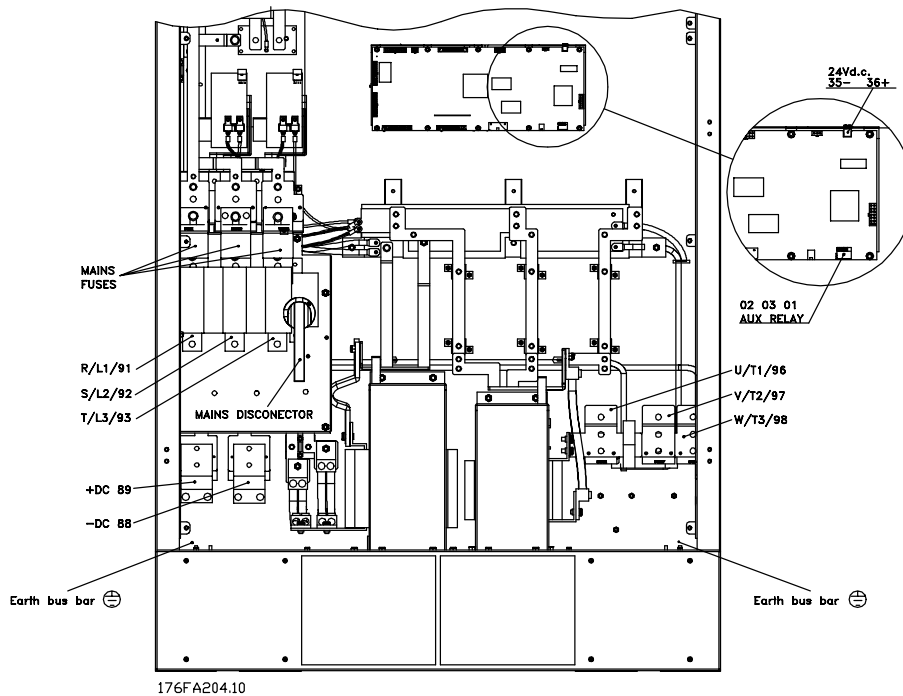
email: esys@esys.us
website: <http://www.esys.us>



■ Electrical installation, power cables



Compact IP 00/Chassis, IP 20/NEMA 1, and IP 54/NEMA 12
VLT 8450-8600 380-480 V without disconnectors and line fuses

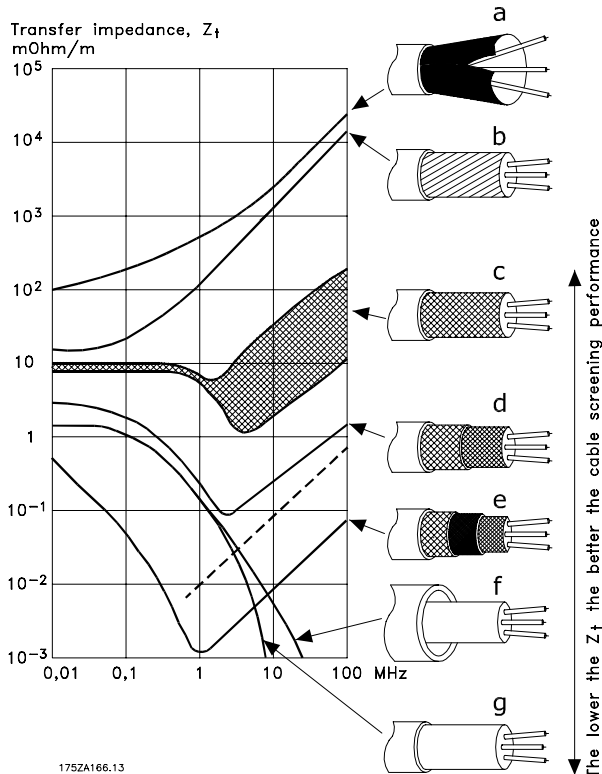


Compact IP 00/Chassis, IP 20/NEMA 1, and IP 54/NEMA 12
VLT 8450-8600 380-480 V with disconnectors and line fuses

■ Use of EMC-correct cables

Braided shielded/armored cables are recommended to optimise EMC immunity of the control cables and the EMC emission from the motor cables.

The ability of a cable to reduce the in- and outgoing radiation of electric noise depends on the transfer impedance (Z_T). The shield of a cable is normally designed to reduce the transfer of electric noise; however, a shield with a lower transfer impedance (Z_T) value is more effective than a shield with a higher transfer impedance (Z_T).



Transfer impedance (Z_T) is rarely stated by cable manufacturers, but it is often possible to estimate transfer impedance (Z_T) by assessing the physical design of the cable.

Transfer impedance (Z_T) can be assessed on the basis of the following factors:

- The conductivity of the shield material.
- The contact resistance between the individual shield conductors.
- The shield coverage, i.e. the physical area of the cable covered by the shield - often stated as a percentage value.
- Shield type, i.e. braided or twisted pattern.

Aluminium-clad with copper wire.

Twisted copper wire or armoured steel wire cable.

Single-layer braided copper wire with varying percentage shield coverage.
This is the typical Danfoss reference cable.

Double-layer braided copper wire.

Twin layer of braided copper wire with a magnetic, shielded/armored intermediate layer.

Cable that runs in copper tube or steel tube.

Lead cable with 1.1 mm wall thickness.

■ **Tightening torque and screw sizes**

The table shows the torque required when fitting terminals to the AFD. For VLT 8006-8032, 200-240 V, VLT 8006-8122, 380-480 and 525-600 V the cables must be fastened with screws. For VLT 8042-8062, 200-240 V and for VLT 8152-8600, 380-480 V, the cables must be fastened with bolts.

These figures apply to the following terminals:

Line terminals (Nos.)	91, 92, 93 L1, L2, L3
Motor terminals (Nos.)	96, 97, 98 U, V, W
Ground terminal (Nos.)	94, 95, 99

VLT type	Tightening-up torque	Screw/bolt size	Allen key size
3 x 200-240 V			
VLT 8006-8011	16 in-lbs/1.8 Nm (IP 20)	M4	
VLT 8006-8016	16 in-lbs/1.8 Nm (IP 54)	M4	
VLT 8016-8027	26.6 in-lbs/3.0 Nm (IP 20)	M5 ³⁾	4 mm/0.16 in
VLT 8022-8027	26.6 in-lbs/3.0 Nm (IP 54) ²⁾	M5 ³⁾	4 mm/0.16 in
VLT 8032	53 in-lbs/6.0 Nm	M6 ³⁾	5 mm/0.20 in
VLT 8042-8062	100 in-lbs/11.3 Nm	M8 (bolt)	
3 x 380-480 V			
VLT 8006-8011	5.3 in-lbs/0.5-0.6 Nm	M3	
VLT 8016-8027	16 in-lbs/1.8 Nm (IP 20)	M4	
VLT 8016-8032	16 in-lbs/1.8 Nm (IP 54)	M4	
VLT 8032-8052	26.6 in-lbs/3.0 Nm (IP 20)	M5 ³⁾	4 mm/0.16 in
VLT 8042-8052	26.6 in-lbs/3.0 Nm (IP 54) ²⁾	M5 ³⁾	4 mm/0.16 in
VLT 8062-8072	53 in-lbs/6.0 Nm	M6 ³⁾	5 mm/0.20 in
VLT 8102-8122	133 in-lbs/15 Nm (IP 20)	M8 ³⁾	6 mm/0.24 in
	213 in-lbs/24 Nm (IP 54) ¹⁾	³⁾	8 mm/0.31 in
VLT 8152-8352	168 in-lbs/19 Nm ⁴⁾	M10 (bolt)	
VLT 8450-8600	372 in-lbs/42 Nm	M12 (bolt)	
3 x 525-600 V			
VLT 8002-8011	5.3 in-lbs/0.5-0.6 Nm	M3	
VLT 8016-8027	16 in-lbs/1.8 Nm	M4	
VLT 8032-8042	26.6 in-lbs/3.0 Nm ²⁾	M5 ³⁾	4 mm/0.16 in
VLT 8052-8072	53 in-lbs/6.0 Nm	M6 ³⁾	5 mm/0.20 in
VLT 8100-8150	100 in-lbs/11.3 Nm	M8	
VLT 8200-8300	100 in-lbs/11.3 Nm	M8	

1. Loadsharing terminals 14 Nm/M6, 5 mm/0.20 in Allen key
2. IP 54 units with RFI filter line terminals 6 Nm
3. Allen screws (hexagon)
4. Loadsharing terminals 84 in-lbs/9.5 Nm/M8 (bolt)

Line connection

Line must be connected to terminals 91, 92, 93.

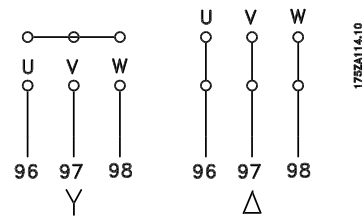
Nos. 91, 92, 93

Line voltage 3 x 200-240 V

L1, L2, L3

Line voltage 3 x 380-480 V

Line voltage 3 x 525-600 V



NOTE

Check that the line voltage corresponds to the line voltage of the AFD, which can be seen from the nameplate.

See *Technical data* for correct sizing of cable cross-sections.



NOTE

It is the responsibility of the user or installer to ensure that proper grounding, branch circuit, and motor overload protection is in accordance with national and local electrical and safety regulations and codes.

Motor connection

The motor must be connected to terminals 96, 97, 98. Ground to terminal 94/95/99.

Nos.

96, 97, 98

Motor voltage 0-100 % of mains voltage

U, V, W

No. 94/95/99

Ground connection

See *Technical data* for correct sizing of cable cross-sections.

All types of three-phase asynchronous standard motors can be used with a VLT 8000 AQUA unit.

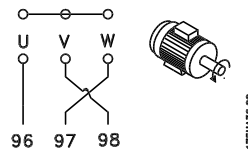
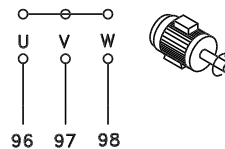
Small-size motors are normally star-connected (220/380 V, Δ/Y). Large-size motors are delta-connected (380/660 V, Δ/Y). The correct connection and voltage can be read from the motor nameplate.



NOTE

In older motors without phase coil insulation, a LC filter should be fitted to the AFD output.

Direction of IEC motor rotation



The factory setting is for clockwise rotation with the VLT frequency transformer output connected as follows.

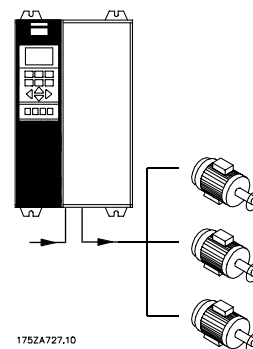
Terminal 96 connected to U-phase

Terminal 97 connected to V-phase

Terminal 98 connected to W-phase

The direction of rotation can be changed by switching two phases in the motor cable.

Parallel coupling of motors



VLT 8000 AQUA is able to control several motors connected in parallel. If the motors are to have different rpm values, the motors must have different rated rpm values. Motor rpm is changed simultaneously, which means that the ratio between the rated rpm values is maintained across the range.

The total current consumption of the motors is not to exceed the maximum rated output current $I_{VLT,N}$ for the AFD.

Problems may arise at the start and at low rpm values if the motor sizes are widely different. This is because the relatively high ohmic resistance in small motors calls for a higher voltage at the start and at low rpm values.

In systems with motors connected in parallel, the electronic thermal relay (ETR) of the AFD cannot be used as motor protection for the individual motor. Consequently, additional motor protection is required, such as thermistors in ground motor (or individual thermal relays).



NOTE

Parameter 107 *Automatic Motor Adaptation, AMA* and *Automatic Energy Optimization, AEO* in parameter 101 *Torque characteristics* cannot be used if motors are connected in parallel.

If it is necessary to break the shield to install a motor isolator or motor contactor, the shield must be continued at the lowest possible HF impedance.

■ **Motor cables**

See *Technical data* for correct sizing of motor cable cross-section and length.

Always comply with national and local regulations on cable cross-sections.



NOTE

If an unshielded cable is used, some EMC requirements are not complied with, see *EMC test results*.

If the EMC specifications regarding emission are to be complied with, the motor cable must be shielded, unless otherwise stated for the RFI filter in question. It is important to keep the motor cable as short as possible so as to reduce the noise level and leakage currents to a minimum.

The motor cable shield must be connected to the metal cabinet of the AFD and to the metal cabinet of the motor. The shield connections are to be made with the biggest possible surface (cable clamp).

This is enabled by different installation devices in the different AFDs. Mounting with twisted shield ends (pigtailed) is to be avoided, since these spoil the shielding effect at higher frequencies.

■ Motor thermal protection

The electronic thermal relay in UL-approved AFD has received UL-approval for single motor protection, as long as parameter 117 *Motor thermal protection* has been set to ETR Trip and parameter 105 *Motor current*, $I_{VLT,N}$ has been programmed for the rated motor current (can be read from the motor nameplate).

■ Ground connection

Since the leakage currents to ground may be higher than 3.5 mA, the AFD must always be grounded in accordance with applicable national and local regulations. In order to ensure good mechanical connection of the ground cable, its cable cross-section must be at least 8 AWG/10 mm². For added security, an RCD (Residual Current Device) may be installed. This ensures that the AFD will cut out if the leakage currents get too high. See RCD Instructions MI.66.AX.02.

■ Installation of 24 Volt external DC supply

Torque: 0.5 - 0.6 Nm
Screw size: M3

No.	Function
35 (-), 36 (+)	24 V external DC supply (available with VLT 8152-8600 380-480 V only)

24 V external DC supply can be used as low-voltage supply to the control card and any option cards installed. This enables full operation of the LCP (incl. parameter setting) without connection to line. Please note that a warning of low voltage will be given when 24 V DC has been connected; however, there will be no tripping. If 24 V external DC supply is connected or switched on at the same time as the line supply, a time of min. 200 msec. must be set in parameter 111, *Start delay*. A pre-fuse of min. 6 Amp, slow-blow, can be fitted to protect the external 24 V DC supply. The power consumption is 15-50 W, depending on the load on the control card.



NOTE

Use 24 V DC supply of type PELV to ensure correct galvanic isolation (type PELV) on the control terminals of the AFD.

■ DC bus connection

The DC bus terminal is used for DC back-up, with the intermediate circuit being supplied from an external DC source.

Terminal nos. Nos. 88, 89

Contact Danfoss if you require further information.

■ High-voltage relay

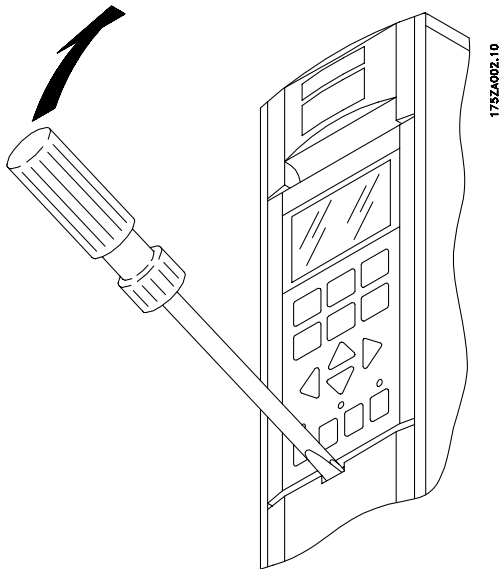
The cable for the high-voltage relay must be connected to terminals 01, 02, 03. The high-voltage relay is programmed in parameter 323, *Relay 1, output*.

No. 1	Relay output 1 1+3 break, 1+2 make. Max. 240 V AC, 2 Amp. Min. 24 V DC, 10 mA or 24 V AC, 100 mA.
Max. cross-section:	4 mm ² /10 AWG.
Torque:	0.5 Nm/5 in-lbs
Screw size:	M3

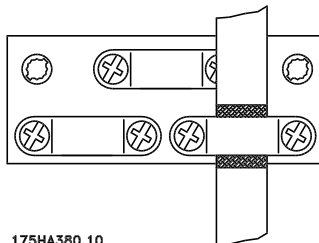
■ Control card

All terminals for the control cables are located under the protective cover of the AFD.

The protective cover (see drawing below) can be removed by means of a pointed object (except IP54/NEMA 12 units) - a screwdriver or similar.



■ Electrical installation, control cables



Torque: 0.5 Nm (5 in-lbs)
Screw size: M3.

Generally speaking, control cables must be shielded/armored and the shield must be connected by means of a cable clamp at both ends to the metal cabinet of the unit (see *Earthing/Grounding of shielded (armoured control cables)*).

Normally, the shield must also be connected to the body of the controlling unit (follow the instructions for installation given for the unit in question).

If very long control cables are used, 50/60 Hz ground loops may occur that will disturb the whole system. This problem can be solved by

connecting one end of the shield to ground via a 100nF capacitor (keeping leads short).

■ Electrical installation, control cables

Torque: 0.5 Nm/5 in-lbs

Screw size: M3

See *Earthing/Grounding of shielded (armoured control cables)* for correct termination of control cables.

16	17	18	19	20	27	29	32	33	61	68	69
D IN	D IN	D IN	D IN	COM D IN	D IN	D IN	D IN	D IN	COM RS485	P RS485	N RS485

04	05	12	13	39	42	45	50	53	54	55	60
RELAY		+24V OUT		COM A OUT	A OUT	A OUT	+10V OUT	A IN	A IN	COM A IN	A IN

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No.	Function
04, 05	Relay output 2 can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs. For the 24 V DC to be used for digital inputs, switch 4 on the control card must be closed, position "on".
16-33	Digital inputs. See parameters 300-307 <i>Digital inputs</i> .
20	Common for digital inputs.
39	Common for analog/digital outputs. See <i>Examples of connection</i> .
42, 45	Analog/digital outputs for indicating frequency, reference, current and torque. See parameters 319-322 <i>Analog/digital outputs</i> .
50	Supply voltage to potentiometer and thermistor 10 V DC.
53, 54	Analog voltage input, 0 - 10 V DC.
55	Common for analog inputs.
60	Analog current input 0/4-20 mA. See parameters 314-316 <i>Terminal 60</i> .

61	Termination of serial communication. See <i>Earthing/Grounding of shielded (armoured control cables)</i> . This terminal is not normally to be used.
68, 69	RS 485 interface, serial communication. When multiple AFD's are connected to a communication bus, switches 2 and 3 on control card in the first and last units must be closed (position ON). For the remaining AFD's, switches 2 and 3 must be open (OFF). The factory setting is closed (position ON).

■ Switches 1-4

The dipswitch is located on the control card. It is used for serial communication and external DC supply. The switching position shown is the factory setting.



Switch 1 has no function.

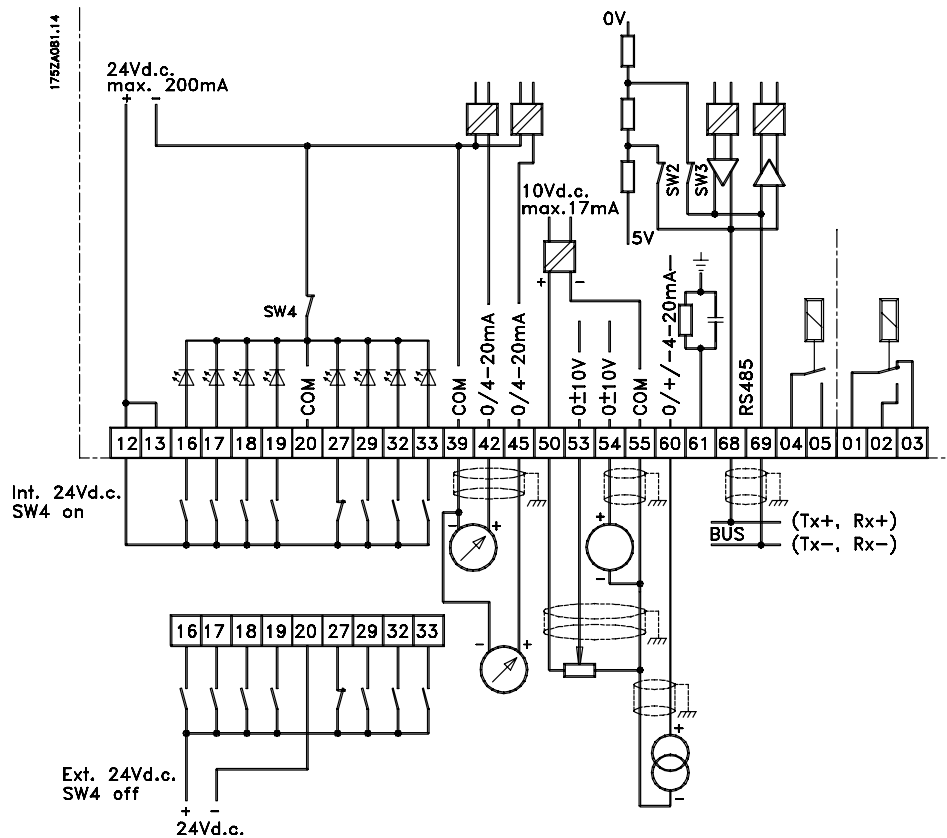
Switches 2 and 3 are used for terminating an RS 485 interface, serial communication. In the first and the last AFD, switches 2 and 3 must be ON. In the other AFD, switches 2 and 3 must be OFF.

Switch 4 is used if an external 24 V DC supply is required for the control terminals. Switch 4 separates the common potential for the internal 24 V DC supply from the common potential of the external 24 V DC supply.



NOTE

Please note that when Switch 4 is in position "OFF", the external 24 V DC supply is galvanically isolated from the AFD.



Bus connection

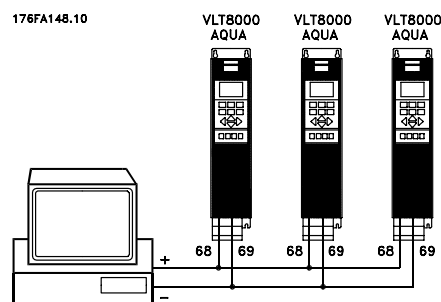
The serial bus connection in accordance with the RS 485 (2-conductor) norm is connected to terminals 68/69 of the AFD (signals P and N). Signal P is the positive potential (TX+,RX+), while signal N is the negative potential (TX-,RX-).

If more than one AFD is to be connected to a given master, use parallel connections.

In order to avoid potential equalizing currents in the shield, the cable shield can be grounded via terminal 61, which is connected to the frame via an RC-link.

Bus termination

The bus must be terminated by a resistor network at both ends. For this purpose, set switches 2 and 3 on the control card for "ON".



■ Connection example VLT 8000 AQUA

The diagram below gives an example of a typical VLT 8000 AQUA installation.

The line supply is connected to terminals 91 (L1), 92 (L2) and 93 (L3), while the motor is connected to 96 (U), 97 (V) and 98 (W). These numbers can also be seen from the terminals of the AFD.

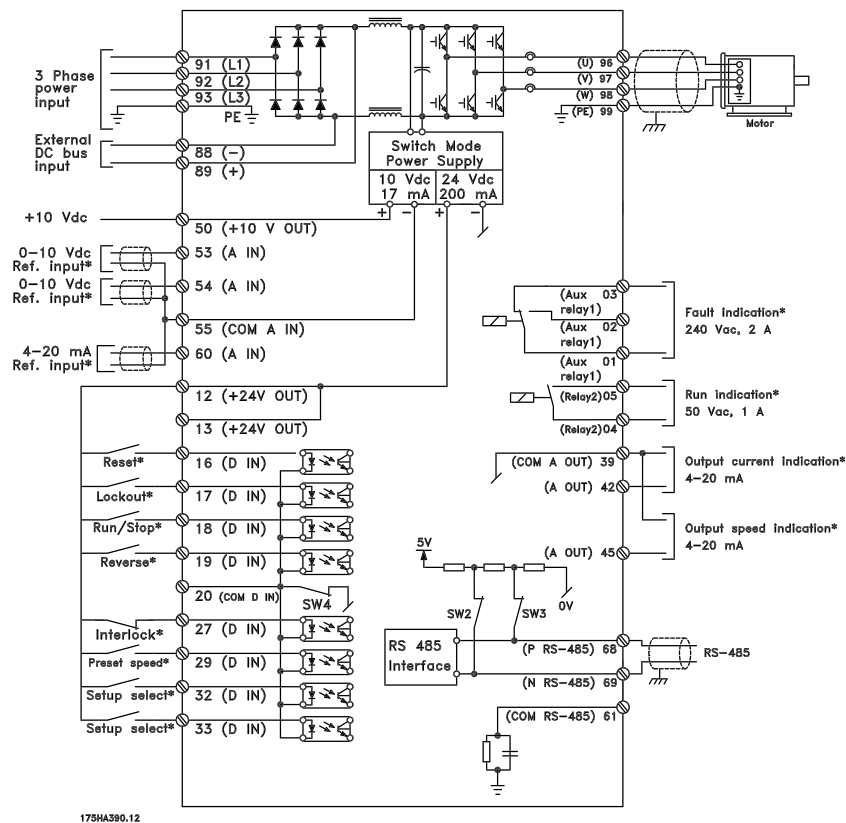
An external DC supply can be connected to terminals 88 and 89.

Analog inputs can be connected to terminals 53 [V], 54 [V] and 60 [mA]. These inputs can be programmed for either reference, feedback or thermistor. See *Analog inputs* in parameter group 300.

There are 8 digital inputs, which are controlled with 24 V DC. Terminals 16-19, 27, 29, 32, 33. These inputs can be programmed in accordance with the table in *Inputs and outputs* 300-328.

There are two analog/digital outputs (terminals 42 and 45), which can be programmed to show the present status or a process value, such as 0-f_{MAX}. Relay outputs 1 and 2 can be used for giving the present status or a warning.

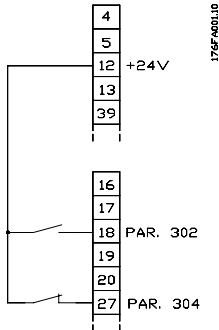
On terminals 68 (P+) and 69 (N-) RS 485 interface, the AFD can be controlled and monitored via serial communication.



* These terminals can be programmed for other functions.

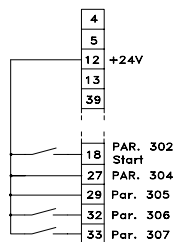
■ Connection examples

■ Single-pole start/stop



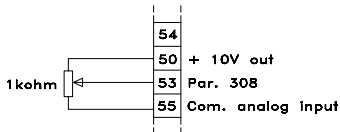
- Start/stop using terminal 18.
Parameter 302 = *Start* [1]
- Quick-stop using terminal 27.
Parameter 304 = *Coasting stop, inverse* [0]

■ Digital speed up/down



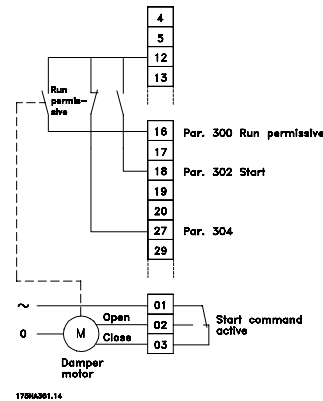
- Speed up and down using terminals 32 and 33.
Parameter 306 = *Speed up* [7]
Parameter 307 = *Speed down* [7]
Parameter 305 = *Freeze reference* [2]

■ Potentiometer reference



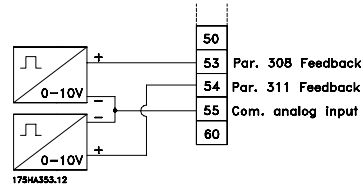
- Parameter 308 = *Reference* [1]
Parameter 309 = *Terminal 53, min. scaling*
Parameter 310 = *Terminal 53, max. scaling*

■ Run permissive



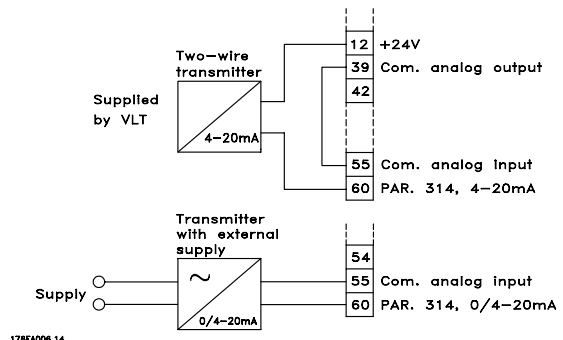
- Start permitted with terminal 16.
Parameter 300 = *Run permissive* [8].
- Start/stop with terminal 18.
Parameter 302 = *Start* [1].
- Quickstop with terminal 27.
Parameter 304 = *Coasting stop, inverse* [0].
- Activated peripheral equip
Parameter 323 = *Start command active* [13].

■ 2-zone regulation



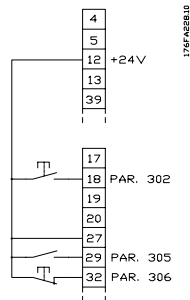
- Parameter 308 = *Feedback* [2].
- Parameter 311 = *Feedback* [2].

■ Transmitter connection



- Parameter 314 = *Reference* [1]
- Parameter 315 = *Terminal 60, min. scaling*
- Parameter 316 = *Terminal 60, max. scaling*

■ 3-wire start/stop



- Stop inverse by means of terminal 32.

Parameter 306 = *Stop inverse* [14]

- Latched start using terminal 18.

Parameter 302 = *Latched start* [2]

- Jog by means of terminal 29.

Parameter 305 = *Jog* [12]

■ Control unit LCP

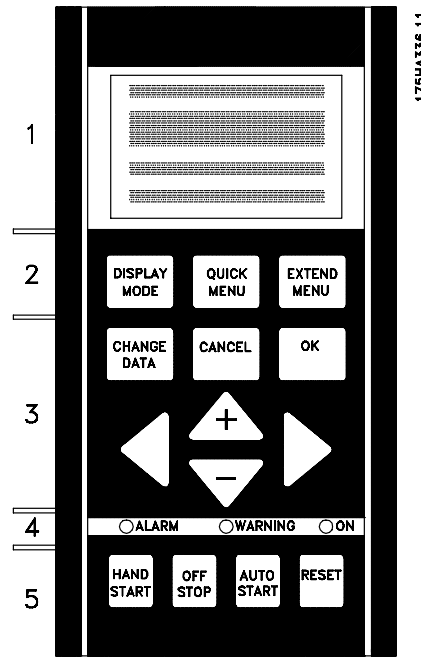
The front of the AFD features a control panel - LCP (Local Control Panel). This is a complete interface for operation and programming of the VLT 8000 AQUA. The control panel is detachable and can - as an alternative - be installed up to 3m/10 ft away from the AFD, e.g. on the front panel, by means of a mounting kit option.

The functions of the control panel can be divided into five groups:

1. Display
2. Keys for changing display mode
3. Keys for changing program parameters
4. Indicator lamps
5. Keys for local operation.

All data are indicated by means of a 4-line alpha-numeric display, which, in normal operation, is able to show 4 operating data values and 3 operating condition values continuously. During programming, all the information required for quick, effective parameter Setup of the AFD will be displayed. As a supplement to the display, there are three indicator lamps for voltage (ON), warning (WARNING) and alarm (ALARM),

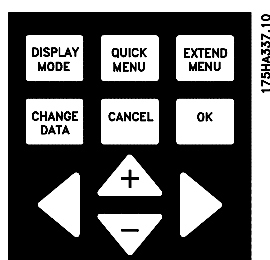
respectively. All AFD parameter Setups can be changed immediately via the control panel, unless this function has been programmed to be *Locked* [1] via parameter 016 *Lock for data change* or via a digital input, parameters 300-307 *Lock for data change*.



Installation

■ Control keys for parameter setup

The control keys are divided into functions. This means that the keys between display and indicator lamps are used for parameter Setup, including selecting the display indication during normal operation.



DISPLAY
MODE

[DISPLAY MODE] is used for selecting the indication mode of the display or when returning to the Display mode from either the Quick menu or the Extend menu mode.



[QUICK MENU] gives access to the parameters used for the Quick menu. It is possible to switch between the Quick menu and the Extend menu modes.



[EXTEND MENU] gives access to all parameters. It is possible to switch between the Extend menu and the Quick menu modes.



[CHANGE DATA] is used for changing a setting selected either in the Extend menu or the Quick menu mode.



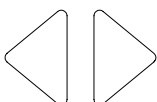
[CANCEL] is used if a change of the selected parameter is not to be carried out.



[OK] is used for confirming a change of the parameter selected.



[+/-] is used for selecting parameters and for changing a chosen parameter. These keys are also used to change the local reference. In addition, the keys are used in Display mode to switch between operation variable readouts.



[<>] is used when selecting a parameter group and for moving the cursor when changing numerical values.

Indicator lamps

At the bottom of the control panel is a red alarm lamp and a yellow warning lamp, as well as a green voltage LED.



If certain threshold values are exceeded, the alarm and/ or warning lamp is activated, and a status or alarm text is displayed.

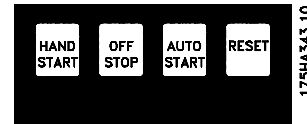


NOTE

The voltage indicator lamp is activated when the AFD receives voltage.

Local control

Underneath the indicator lamps are keys for local control.



[HAND START] is used if the AFD is to be controlled via the control unit. The AFD will start the motor, since a start command is given by means of [HAND START].

On the control terminals, the following control signals will still be active when [HAND START] is activated:

- Hand start - Off stop - Auto start
- Safety Interlock
- Reset
- Coasting stop inverse
- Reversing
- Setup select lsb - Setup select msb
- Jog
- Run permissive
- Lock for data change
- Stop command from serial communication



NOTE

If parameter 201 *Output frequency low limit* f_{MIN} is set to an output frequency greater than 0 Hz, the motor will start and ramp up to this frequency when [HAND START] is activated.



[OFF/STOP] is used for stopping the connected motor. Can be selected as Enable [1] or Disable [0] via parameter 013. If the stop function is activated, line 2 will flash.



[AUTO START] is used if the AFD is to be controlled via the control terminals and/or serial communication. When a start signal is active on the control terminals and/or the bus, the AFD will start.

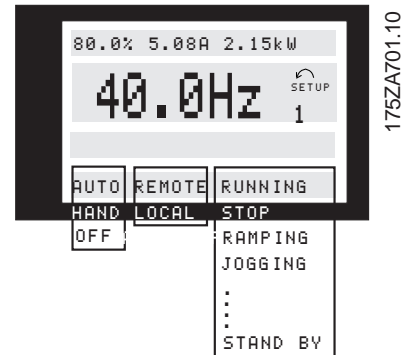


NOTE

An active HAND-OFF-AUTO signal via the digital inputs will have higher priority than the control keys [HAND START]-[AUTO START].



[RESET] is used for resetting the AFD after an alarm (trip). Can be selected as *Enable* [1] or *Disable* [0] via parameter 015 *Reset on LCP*. See also *List of warnings and alarms*.



■ Display mode

In normal operation, any 4 different operating variables can be indicated continuously: 1.1 and 1.2 and 1.3 and 2. The present operating status or alarms and warnings that have arisen are shown in line 2 in the form of a number. In the case of alarms, the alarm in question will be shown in lines 3 and 4, accompanied by an explanatory note. Warnings will flash in line 2, with an explanatory note in line 1. In addition, the display shows the active Setup. The arrow indicates the direction of rotation; here the AFD has an active reversing signal. The arrow body disappears if a stop command is given or if the output frequency falls below 0.01 Hz. The bottom line gives the status of the AFD. The scroll list on the next page gives the operating data that can be shown for variable 2 in display mode. Changes are made via the [+/-] keys.

1st line
2nd line
3rd line
4th line



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■ Display mode, cont.

Three operating data values can be shown in the first display line, while one operating variable can be shown in the second display line. To be programmed via parameters 007, 008, 009 and 010 *Display read-out*.

- Status line (4th line):

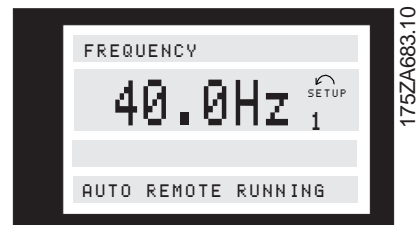
The left part of the status line indicates the control element of the AFD that is active. AUTO means that control is via the control terminals, while HAND indicates that control is via the local keys on the control unit. OFF means that the AFD ignores all control commands and stops the motor.

The centre part of the status line indicates the reference element that is active. REMOTE means that the reference from the control terminals is active, while LOCAL indicates that the reference is determined via the [+/-] keys on the control panel.

The last part of the status line indicates the current status, for example "Running", "Stop" or "Alarm".

■ Display mode I

VLT 8000 AQUA offers different display modes depending on the mode selected for the AFD. Below is a display mode, in which the AFD is in Auto mode with remote reference at an output frequency of 40 Hz. In this display mode, reference and control are determined via the control terminals. The text in line 1 gives the operating variable shown in line 2.



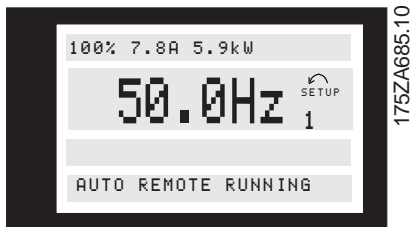
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Line 2 gives the current output frequency and the active Setup.

Line 4 says that the AFD is in Auto mode with remote reference, and that the motor is running.

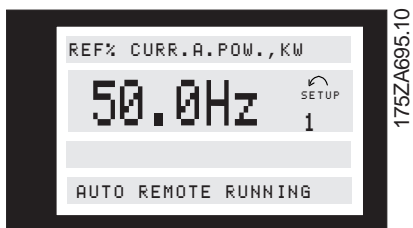
■ Display mode II:

This display mode makes it possible to have three operating data values displayed at the same time in line 1. The operating data values are determined in parameters 007-010 *Display readout*.



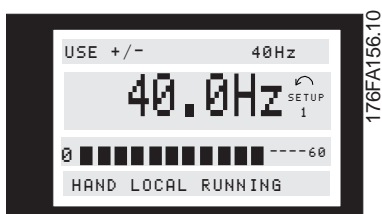
■ Display mode III:

This display mode is active as long as the [DISPLAY MODE] key is kept depressed. In the first line, operating data names and units of operating data are displayed. In the second line, operating data 2 remains unchanged. When the key is released, the different operating data values are shown.

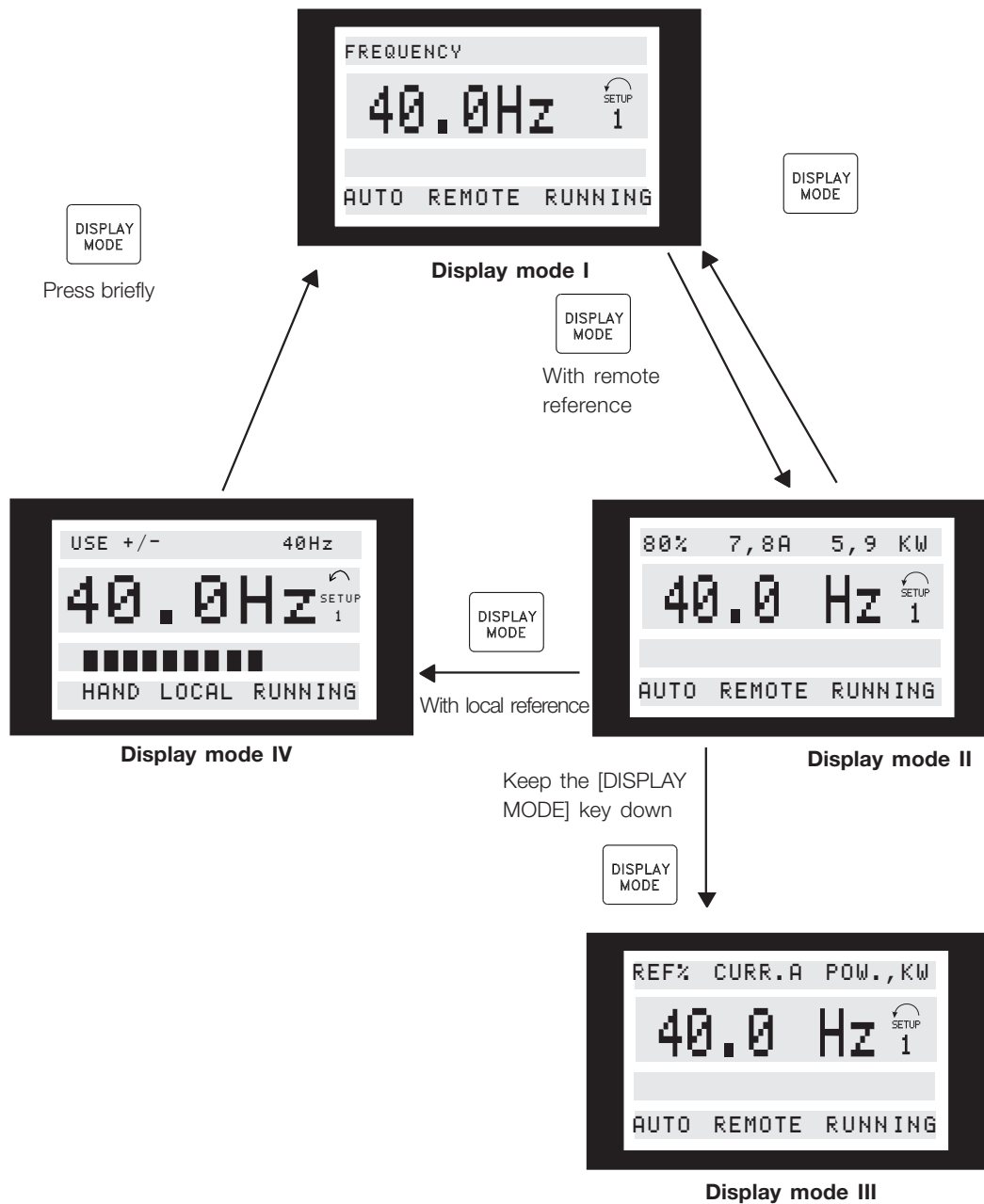


■ Display mode IV:

This display mode is only active in connection with local reference, see also *Reference handling*. In this display mode, the reference is determined via the [+/-] keys and control is carried out by means of the keys underneath the indicator lamps. The first line indicates the required reference. The third line gives the relative value of the present output frequency at any given time in relation to the maximum frequency. The display is in the form of a bar graph.



■ Navigation between display modes



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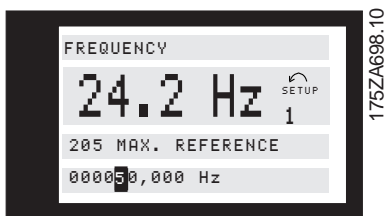
■ Changing data

Regardless of whether a parameter has been selected under the Quick menu or the Extended menu, the procedure for changing data is the same.

Pressing the [CHANGE DATA] key allows change of the selected parameter, and the underlining in line 4 will flash on the display.

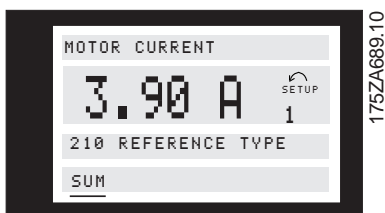
The procedure for changing data depends on whether the selected parameter represents a numerical data value or a functional value.

If the chosen parameter represents a numeric data value, the first digit can be changed by means of the [+/-] keys. If the second digit is to be changed, first move the cursor by using the [<>] keys, then change the data value using the [+/-] keys.



The selected digit is indicated by a flashing cursor. The bottom display line gives the data value that will be entered (saved) when signing off by pressing the [OK] button. Use [CANCEL] to cancel the change.

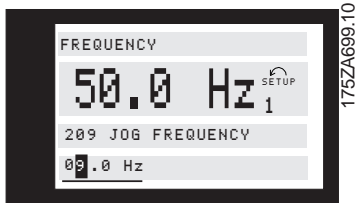
If the selected parameter is a functional value, the selected text value can be changed by means of the [+/-] keys.



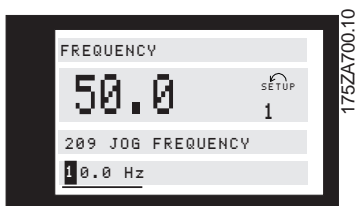
The functional value flashes until signing off by pressing the [OK] button. The functional value has now been selected. Use [CANCEL] to cancel the change.

■ Infinitely variable change of numeric data value

If the chosen parameter represents a numeric data value, a digit is first selected by means of the [<>] keys.



Then the chosen digit is changed infinitely by means of the [+/-] keys:



The chosen digit flashes. The bottom display line shows the data value that will be entered (saved) when signing off with [OK].

■ Changing of data value, step-by-step

Certain parameters can be changed both step by step and infinitely variably. This applies to *Motor power* (parameter 102), *Motor voltage* (parameter 103) and *Motor frequency* (parameter 104).

This means that the parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

■ Manual initialization

Disconnect from line and hold the [DISPLAY MODE] + [CHANGE DATA] + [OK] keys down while at the same time reconnecting the line supply. Release the keys; the AFD has now been programmed for the factory setting.

The following parameters are not zeroed by means of manual initialization:

Parameter	500, <i>Protocol</i>
	600, <i>Operating hours</i>
	601, <i>hours run</i>
	602, <i>kWh counter</i>
	603, <i>Number of power-ups</i>
	604, <i>Number of overtemperatures</i>
	605, <i>Number of overvoltages</i>

It is also possible to carry out initialization via parameter 620 *Operating mode*.

■ Quick Menu

The QUICK MENU key gives access to 12 of the most important setup parameters of the drive. After programming, the drive will, in many cases, be ready for operation. The 12 Quick Menu parameters are

shown in the table below. A complete description of the function is given in the parameter sections of this manual.

Quick Menu Item Number	Parameter Name	Description
1	001 Language	Selects language used for all displays.
2	102 Motor Power	Sets output characteristics of drive based on kW size of motor.
3	103 Motor Voltage	Sets output characteristics of drive based on voltage of motor.
4	104 Motor Frequency	Sets output characteristics of drive based on nominal frequency of motor. This is typically equal to line frequency.
5	105 Motor Current	Sets output characteristics of drive based on nominal current in amps of motor.
6	106 Motor Nominal Speed	Sets output characteristics of drive based on nominal full load speed of motor.
7	201 Minimum Frequency	Sets minimum controlled frequency at which motor will run.
8	202 Maximum Frequency	Sets maximum controlled frequency at which motor will run.
9	206 Ramp Up Time	Sets time to accelerate motor from 0 Hz to nominal motor frequency set in Quick Menu Item 4.
10	207 Ramp Down Time	Sets time to decelerate motor from nominal motor frequency set in Quick Menu Item 4 to 0 Hz.
11	323 Relay 1 Function	Sets function of high voltage Form C relay.
12	326 Relay 2 Function	Sets function of low voltage Form A relay.

■ Parameter Data

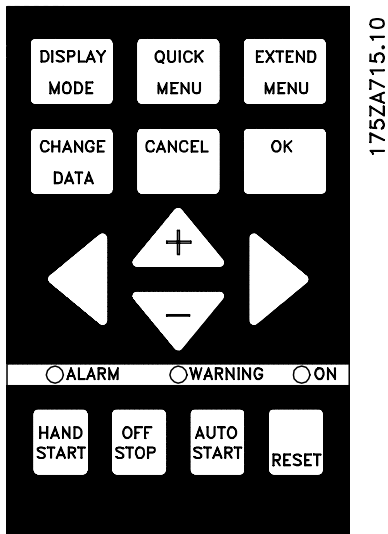
Enter or change parameter data or settings in accordance with the following procedure.

1. Press Quick Menu key.
2. Use '+' and '-' keys to find parameter you choose to edit.
3. Press Change Data key.
4. Use '+' and '-' keys to select correct parameter setting. To move to a different digit within parameter, use < and > arrows. *Flashing cursor indicates digit selected to change.*
5. Press Cancel key to disregard change, or press OK key to accept change and enter new setting.

Assume parameter 206, *Ramp Up Time*, is set at 60 seconds. Change the ramp up time to 100 seconds in accordance with the following procedure.

1. Press Quick Menu key.
2. Press '+' key until you reach Parameter 206, *Ramp Up Time*.
3. Press Change Data key.
4. Press < key twice – hundreds digit will flash.
5. Press '+' key once to change hundreds digit to '1.'
6. Press > key to change to tens digit.
7. Press '-' key until '6' counts down to '0' and setting for *Ramp Up Time* reads '100 s.'
8. Press OK key to enter new value into drive controller.

Example of Changing Parameter Data



NOTE

Programming of extended parameters functions available through EXTENDED MENU key is done in accordance with same procedure as described for Quick Menu functions.



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